1.0

1.1

1.25 1.4 1.6

2.8 2.5

3.2 2.2

3.6

4.0 2.0

1.8

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU

METROPOLITAN WASHINGTON AIRPORT INVESTMENT REQUIREMENTS

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September 1977

Technical Supplement to
The Metropolitan Washington Airport Policy Analysis

Prepared for

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16. Abstract

The Federal Aviation Administration (FAA), as owner and operator of the Metropolitan Washington Airports, Washington National and Dulles International, is issuing a policy statement to guide development and operation of these facilities into the 1990's. The FAA's Metropolitan Washington Airport policy establishes a balance between a complex set of criteria which reflect transportation service, investment requirements, and environmental impacts.

This report presents the results of an analysis of the impact of policy alternatives on capital investment requirements for the Metropolitan Washington Airports. A description of the range of policy options considered is contained in the introduction to the report.

The FAA is recommending limiting air carrier aircraft operations at National Airport to 40 per hour, and furthermore, authorizing wide body aircraft at National, with the understanding that wide body service there would average four departures per hour by 1990. Estimated investments at National and Dulles required to support the recommended policy total approximately $119 million in 1976 dollars. Given the uncertainties of investment forecasting, however, there are no significant differences in investment requirements between the policy alternatives evaluated.

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INVESTMENT REQUIREMENTS

I. Introduction

This workpaper presents an analysis of investments required, in a system of airports serving air carrier airlines in the Washington D. C. Region, assuming varying policies for the operation of National Airport. The airports considered are National Airport (DCA), Dulles Airport (IAD) and the Baltimore-Washington Airport (BWI). The alternative policies examined are as follows:

Case	Description
2(Baseline)	Hold DCA slots at 40 per hour and do not allow wide body aircraft.
6	Reduce DCA slots to 20 per hour and do not allow wide body aircraft. In this scenario, growth at National Airport is constrained by reducing airline quotos.
13	Hold DCA slots at 40 per hour and allow wide body aircraft. Here, growth is accommodated with new technology aircraft.[1]
17	Reduce DCA slots to 30 per hour and allow wide body aircraft. Thus, scenario represents a combination of Case 6 and Case 13.

[1]/A supporting analysis indicates that airlines, if allowed, would introduce wide body aircraft at DCA at an average frequency of four per hour. Refer to "Wide Body Aircraft Use at National Airport", DOT, FAA, 1976.

II. General Information

The range of alternatives investigated in this work
paper presents a general indication of the impact of
adopting different policies for aircraft use at National
Airport - specifically the impact upon the future levels
of inyestment required at the three airports. The neces-
sity of analyzing all three, as a system, is most pro-
nounced when one considers that a change in policy at
National could create the need for an additional invest-
ment of millions of dollars at the other two airports.

In terms of the impact of each policy, the investment
requirements are sensitive to two primary demands; (1)
the demand for space at the airport by different numbers
and types of aircraft during the peak periods, and (2)
the demand for facilities to accommodate varying numbers
of passengers from the access roadways to the holdrooms
and loading bridges. The basic assumption of the analysis
is that for a constant regional demand a constraint on use
at National would result in a demand for increased facili-
ties at the other two airports.

The investment requirements were determined independently
of other studies, however, to the extent that it was ap-
plicable,information from all available studies was utiliz-
ed in formulating this report. Specificly, the data sources
include past reports on expansion capabilities at National,
the various information items relating to the current expan-
sion program at Baltimore-Washington and earlier development
concepts for Dulles.

At the time of preparation of this report, a development program was under way at Baltimore-Washington International Airport. This program will provide terminal facilities designed to meet long range growth and for this study was considered adequate to meet the design level of 11.2 million passengers per year. It was also assumed that policy decisions for the operation of National would not act to reduce the scope of the terminal expansion project at BWI.

These cost estimates do not represent the total expenditures that will be required at each airport. Maintenance, new airfield facilities and other improvements will be identified through Master Plans of National and Dulles. These estimates are prepared only as an indication of relative sensitivity to varying levels and types of demands influenced by the operating policies of National Airport.

III. Summary of Findings

In summary, it is appropriate to note certain factors which influence the requirements in investment for the various modes. Those are:

1. The current development program at the Baltimore-Washington International Airport is a commitment of funding independent of National Airport Policy. The level of demand projected under this analysis does not, in any mode, exceed the design capacity of the proposed BWI facilities. Therefore, modes which cause a shift of passengers to BWI reflect no additional cost at that facility and result in a reduction of costs at National. Therefore, for a more sensitive comparison of available alternatives, the costs of BWI can be deleted as it is constant throughout the analysis.

.2. The investment required in the terminal to accommodate additional passengers at National Airport is multiplied by the high cost of providing automobile parking facilities to serve those passengers. However, the per passenger costs at Dulles are significantly higher than for National.

3. The effect of introducing wide-body aircraft at National appears to be in the range of $10 million if a comparison is made between Cases 2 and 17 which handle approximately the same number of passengers. Case 17, with wide-body aircraft, handles about five percent fewer passengers in 1990 but costs about $8 million more. Case 13, on the other hand, has the same number of aircraft as Case 2, and handles seven percent more passengers and costs $16 million more with wide-body aircraft.

To better consider the required investment to accommodate the demand, a series of indices were analyzed on a per passenger basis. This provides a gauge of a balance between investments and identifies the mode which provides the lowest investment requirement per passenger served. The results indicate that Case 2 offers the lowest investment per passenger, however, the variance between modes was not considered to be significant (12%).

The summary of costs and the per passenger investments are presented in the following Table 1 and 2.

SUMMARY OF COSTS
(All Costs Are In Millions of 1976 Constant Dollars)

COST ESTIMATES-NATIONAL

CASE	Airside	Terminal	Groundside	Total
Current Demand	$0.63	$33,37	$ 8.28	$42.28
2	0.81	34.34	12.28	47.43
6	-	15.04	1.33	16.37
13	2.59	42.86	17.72	63.18
17	2.20	34.62	18.72	55.54

COST ESTIMATES-DULLES

CASE	Airside	Terminal	Groundside	Total
2	$10.30	$38.90	$ 6.8	$ 56.00
6	23.50	69.50	12.7	105.70
13	12.40	38.60	5.1	56.10
17	12.40	37.40	7.5	57.30

COST ESTIMATES-BALTIMORE

Current development program meets estimated requirements for all modes; cost is $64.50 million.

AIRPORT SYSTEM COSTS

CASE	DCA	BWI	IAD	3 Airport Total	DC &IAD Total
2	$47.43	$64.50	$ 56.00	$167.93	$103.43
6	16.37	64.50	105.70	186.57	122.07
13	63.18	64.50	56.10	183.78	119.28
17	55.54	64.50	57.30	177.34	112.84

Table 2

CUMMULATIVE PER PASSENGER INVESTMENTS

Washington National

CASE	Cummulative Epl. 1976-1990 1/	Total Cost	$/Epl.
2	109.13M	$47.43M	0.43
6	79.88M	16.37M	0.20
13	116.63M	63.18M	0.54
17	106.13M	55.54M	0.52

Dulles

CASE	Cummulative Epl. 1976-1990	Total Cost	$/Epl.
2	50.10M	56.00	1.12
6	76.35M	105.70	1.38
13	44.10M	56.10	1.27
17	52.35M	57.30	1.09

Washington National and Dulles

CASE	$/Epl.
2	0.65
6	0.78
13	0.74
17	0.71

1/ Assumes a straight line growth from current
level of enplanements to the 1990 forecast.

IV. Demand Profiles

The demand for aviation facilities and services at
all airports will vary dependent upon the policy
adopted at National Airport. The specific variations
expected to affect the investment requirements are
the aircraft demands (peak number at the terminal
and the type) and the passenger demands (peak flow
in each direction and annual levels).

Certain basic factors are assumed to be constant to all
three airports and are thus used to analyze the demand.
The first is the passenger directional flow balance. The
standard assumption of 60% - 40%, which assumes that dur-
ing the peak hour for enplaning passengers approximately
2/3 that number are deplaning. These assumptions were
checked using CAB data for 1975 and found to be accurate
with plus or minus a few percent. 1/ Table 3 shows the
directional flow during the peak hour for enplanements at
each of the three airports individually and combined and
the enplanements as a percent of the total passenger activity
during that hour. Also shown in the same Table are the air-
craft arrivals and departures and the directional flow.

1/ Profiles of Scheduled Air Carrier Passenger Traffic,
   FAA, January 1976.

Table 3

PASSENGER DIRECTIONAL FLOW

(CAB Data, May 1975)

	Peak Hour Enplanements	Same Hour Deplanements	Enplanements as a % of Total
BWI	418	322	56%
DCA	1,506	1,251	55%
IAD	999	467	68%
Total 1/	2,923	2,040	61%

AIRCRAFT DIRECTIONAL FLOW

(OAG Schedules November 1, 1974)

	Peak Hour Departures	Same Hour Arrivals	Departures as a % of Total
BWI	14	12	54%
DCA	26	21	55%
IAD	14	7	67%

Note: Peak hour for departures at the three airports did not coincide.

Also included in the determination of terminal require-
ments is the length of time the average aircraft occupies
a gate. This also has been found to be correlated to the
aircraft size. While load factors and airline scheduling
also play an important part of this a check of schedules
at various airports and other studies have provided a
dwell time for each size aircraft. 2/

1/ For sample period all three airports had simultaneous
   peak hours for enplanements at 5 - 6 PM.

2/ Sources: Washington National Airport Master Plan Report,
   1968; IATA Terminal Design Standards; FAA Facility Re-
   quirements for Large Hubs; Official Airline Guide-July 15,
   1976.

The following tabulation provides these dwell times:

TERMINAL DWELL TIME

Aircraft Seating Capacity	Dwell Time
30	20 min.
50	22
95	27
125	31
200	39
250	45
350	56

It should be noted that these factors can not be converted directly to gate requirements without certain refinements. The character of the airport itself will dictate different "gate occupancy" rates. The "exclusive gate" arrangement at most airports prohibits an occupancy of more than about one-half of the gates at a given time. Two noted exceptions to this, however, are National and LaGuardia which achieve as high as 55-65 percent occupancy during peak periods. Another criteria in determining the number of gates required is the level of enplaned passengers as shown in Figure 1. This graph also illustrates the high utilization of gates at the aforementioned airports.

The peak hour gate requirements can then be determined by application of the following formula:

$$\text{Number of Gates} = \text{Number of Peak Hour Departures} \times \text{Peak Hour Factor}$$

where

$$\text{Peak Hour Factor} = \frac{\text{Dwell Time (in hours)} \times 2}{\text{Gate Occupancy Factor}}$$

Figure 1

TERMINAL GATES PER ANNUAL ENPLANEMENTS

1973 ANNUAL ENPLANEMENTS (IN MILLIONS) FOR
SCHEDULED DOMESTIC OPERATIONS — 60 AIRPORTS

APPROXIMATE NUMBER OF TERMINAL GATES
(1973-AUGUST) CONSIDERED AS ACTIVE LOADING
POSITIONS (SCHEDULE OPS.-DOMESTIC ONLY)

Data points labeled: ORD, ATL, LAX, SFO, LGA, DCA, DEN, BOS, DTW, CLE, PHL, EWR, MSP, PIT, TPA, SEA, LAS, MSY, MEM, PDX, SLC, BUF, CLT, BAL, BDL, MKE, FLL

1 AIRPORTS, 1 AIRPORTS, 1 AIRPORTS, 9 AIRPORTS, 33 AIRPORTS
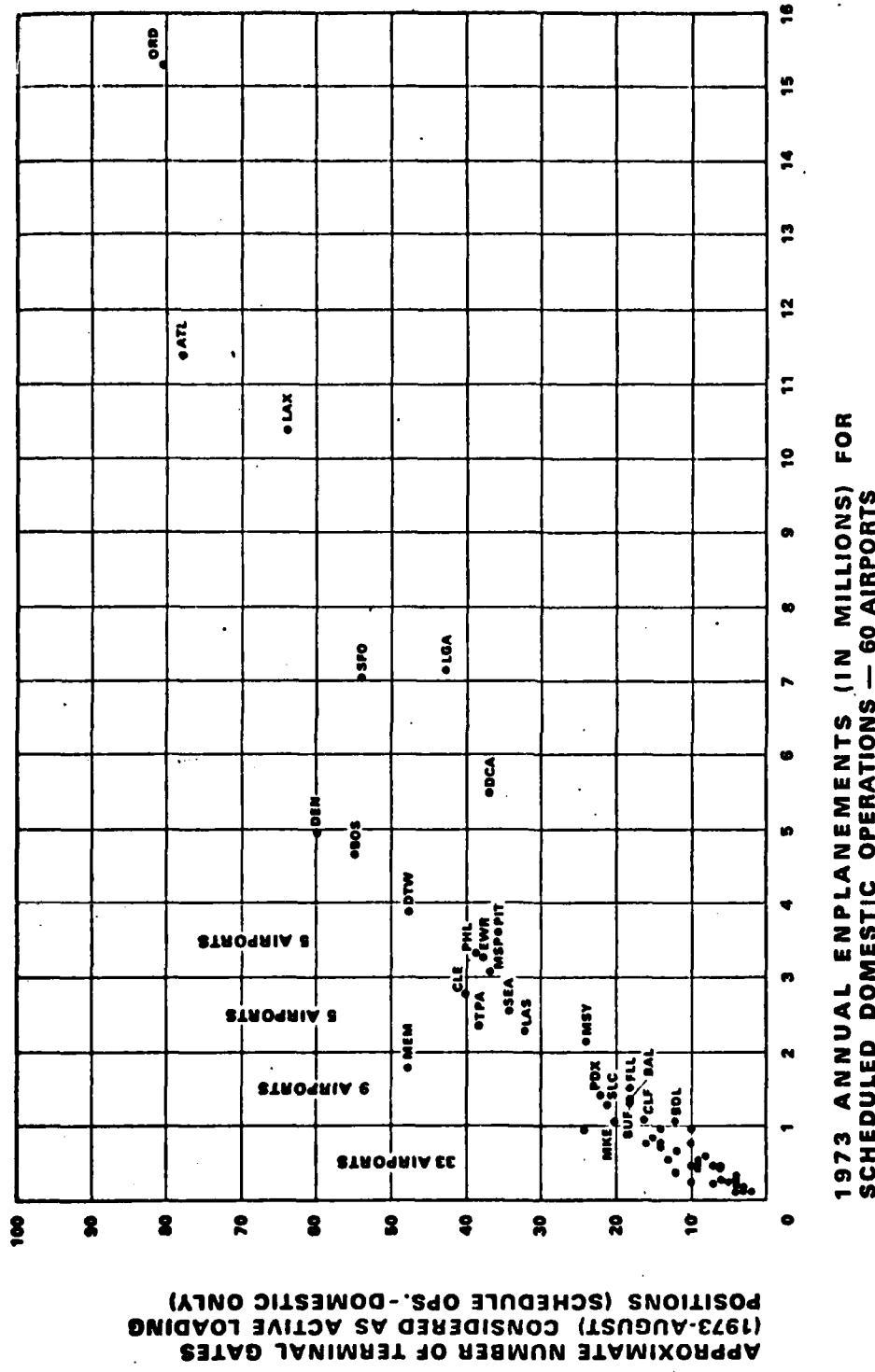
Source: The Apron and Terminal Building: Planning Manual, FAA,
July 1975.

-10-

As previously explained, the gate occupancy factor
employed in this study is 60 percent. The Dwell Time
for each aircraft type has been enumerated as well.
The factor of two must be used to reflect two condi-
tions. Firstly, with a high gate occupancy, aircraft
arriving in the peak hour but not departing in the
same peak hour will require a gate. Secondly, as will
be discussed in ensuing paragraphs, airline scheduling
practices are such that peaks within the peak hour oc-
cur. For example, a 30 seat aircraft has a 20 minute
dwell time. Theoretically, if efficiently scheduled, one
gate could accommodate 3 aircraft in any given hour.
In practice, this rarely occurs and must be reflected
in gate requirement factors.

The peak hour factors employed in this study are as
follows:

Peak Hour Gate Utilization Factors

Aircraft Seating Capacity	Peak Hour Factor
30	1.12
50	1.22
95	1.50
125	1.72
200	2.17
250	2.50
350	3.11

The specific characteristics of the future demand at the
three airports varies with each alternative mode. Tables
4a and 4e present the basic data relating to facility,

TABLE 4a

CASE 2

FORECAST OF DEPARTURES DURING PEAK PERIODS

AIRCRAFT TYPE	NATIONAL			BALTIMORE-WASHINGTON			DULLES		
	11-12 AM	12-1 PM	1-2 PM	7-8 AM	8-9 AM	9-10 AM	7-8 AM	8-9 AM	9-10 AM
30	3	4	-	-	5	1	-	-	-
50	2	1	1	-	1	-	-	-	1
95	-	3	7	16	11	12	15	9	18
125	20	21	13	3	2	5	4	1	4
200	-	-	-	1	-	1	1	-	1
250	-	-	-	-	6	1	-	12	3
350	-	-	-	-	-	-	-	-	-
500	-	-	-	-	-	-	-	-	-
TOTAL	25	29	21	20	25	20	20	22	27

CASE 2

FORECAST OF ENPLANING PASSENGER ACTIVITY

ITEM	DCA	BWI	IAD	CDCA [1]
ANNUAL	8.2×10^6	3.6×10^6	5.4×10^6	0.5×10^6
AVERAGE DAY	24,273	10,670	16,034	1,352
PEAK HOUR	1,963	1,505	2,411	56
PEAK HOUR TIME	5 - 6 PM	8 - 9 AM	8 - 9 AM	N/A

[1] CDCA (COMMUTER ACTIVITY AT NATIONAL AIRPORT) IS ALWAYS TAKEN DURING THE PEAK HOUR FOR DCA.

NOTE: FORECAST YEAR IS 1990.

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CASE 6
FORECAST OF DEPARTURES DURING PEAK PERIODS

AIRCRAFT TYPE	NATIONAL			BALTIMORE-WASHINGTON			DULLES		
	11-12 AM	12-1 PM	1-2 PM	7-8 AM	8-9 AM	9-10 AM	7-8 AM	8-9 AM	9-10 AM
30	2	3	-	-	4	1	-	-	-
50	2	3	1	-	1	-	-	-	1
95	-	-	2	16	12	13	8	6	27
125	10	14	8	3	1	5	11	6	13
200	-	-	-	1	1	1	-	1	3
250	-	-	-	-	6	1	1	12	3
350	-	-	-	-	-	-	-	-	1
500	-	-	-	-	-	-	-	-	-
TOTAL	14	20	11	20	25	21	20	25	48

CASE 6

FORECAST OF ENPLANING PASSENGER ACTIVITY

ITEM	DCA	BWI	IAD	CDCA [1]
ANNUAL	4.3×10^6	3.9×10^6	8.9×10^6	0.5×10^6
AVERAGE DAY	12,791	11,485	26,446	1,481
PEAK HOUR	1,140	1,661	3,571	55
PEAK HOUR TIME	5 - 6 PM	8 - 9 AM	9 - 10 AM	N/A

[1] CDCA (COMMUTER ACTIVITY AT NATIONAL AIRPORT) IS ALWAYS TAKEN DURING THE PEAK HOUR FOR DCA.

NOTE: FORECAST YEAR IS 1990.

CASE 13
FORECAST OF DEPARTURES DURING PEAK PERIODS

AIRCRAFT TYPE	NATIONAL			BALTIMORE-WASHINGTON			DULLES		
	11-12 AM	12-1 PM	1-2 PM	7-8 AM	8-9 AM	9-10 AM	7-8 AM	8-9 AM	9-10 AM
30	3	4	-	-	5	1	-	3	-
50	2	1	1	-	1	-	-	-	1
95	1	6	11	16	10	9	16	8	11
125	15	14	5	3	3	4	3	2	3
200	-	1	-	1	-	-	1	1	1
250	4	3	4	-	6	1	-	11	2
350	-	-	-	-	-	-	-	-	-
500	-	-	-	-	-	-	-	-	-
TOTAL	25	29	21	20	25	15	20	25	18

CASE 13
FORECAST OF ENPLANING PASSENGER ACTIVITY

ITEM	DCA	BWI	IAD	CDCA _1|
ANNUAL	9.2×10^6	3.4×10^6	4.6×10^6	0.5×10^6
AVERAGE DAY	27,151	10,077	13,721	1,352
PEAK HOUR	2,191	1,559	2,400	56
PEAK HOUR TIME	5 - 6 PM	8 - 9 AM	8 - 9 AM	N/A

_1| CDCA (COMMUTER ACTIVITY AT NATIONAL AIRPORT) IS ALWAYS TAKEN DURING THE PEAK HOUR FOR DCA.

NOTE: FORECAST YEAR IS 1990.

CASE 17

FORECAST OF DEPARTURES DURING PEAK PERIODS

AIRCRAFT TYPE	NATIONAL			BALTIMORE-WASHINGTON			DULLES		
	11-12 AM	12-1 PM	1-2 PM	7-8 AM	8-9 AM	9-10 AM	7-8 AM	8-9 AM	9-10 AM
30	4	4	-	-	4	1	-	3	-
50	2	1	1	-	1	-	-	-	1
95	-	1	5	16	11	10	15	8	23
125	11	14	6	3	3	5	4	2	4
200	-	1	-	1	-	-	1	1	1
250	4	3	4	-	6	1	-	11	2
350	-	-	-	-	-	-	-	-	-
500	-	-	-	-	-	-	-	-	-
TOTAL	21	24	16	20	25	17	20	25	31

CASE 17

FORECAST OF ENPLANING PASSENGER ACTIVITY

ITEM	DCA	BWI	IAD	CDCA 1/
ANNUAL	7.8×10^6	3.7×10^6	5.7×10^6	0.5×10^6
AVERAGE DAY	23,047	10,833	16,938	1,374
PEAK HOUR	1,904	1,568	2,354	56
PEAK HOUR TIME	5 - 6 PM	8 - 9 AM	8 - 9 AM	N/A

1/ CDCA (COMMUTER ACTIVITY AT NATIONAL AIRPORT) IS ALWAYS
TAKEN DURING THE PEAK HOUR FOR DCA.

NOTE: FORECAST YEAR IS 1990.

and in turn the investment, requirements. A review of the
detailed forecast data revealed that a given peak level of
aircraft departures frequently occurred more than once per
day thus the critical peak hour was assumed to be the
one with the highest activity in two adjacent hours.
The importance of examining more than one isolated
hour becomes apparent when the aircraft departing dur-
ing the peak hour arrived at the terminal during the
previous hour, while aircraft scheduled to depart during
the previous hour were still at the gate. This feature is
illustrated in Figure 2, which depicts the forecasted
three-hour segment of arrivals and departures for National
Airport under Case 2. The airlines also establish schedules
in a manner that does not evenly distribute flights through-
out the hour thus some parking will actually occur within
the hour as noted in Figure 3.

The demand for facilities is, as discussed earlier, related
to both numbers of aircraft and passenger activity levels.
These two peaks do not necessarily coincide thus the peak
demand for passenger facilities does not necessarily occur
during the same hour as does the peak deamand for aircraft
space and facilities.

FIGURE 2

WASHINGTON NATIONAL AIRPORT
Sample Theoretical Distribution of
Arriving and Departing Flights
(Example is for 1990 Demand Under Case-2)
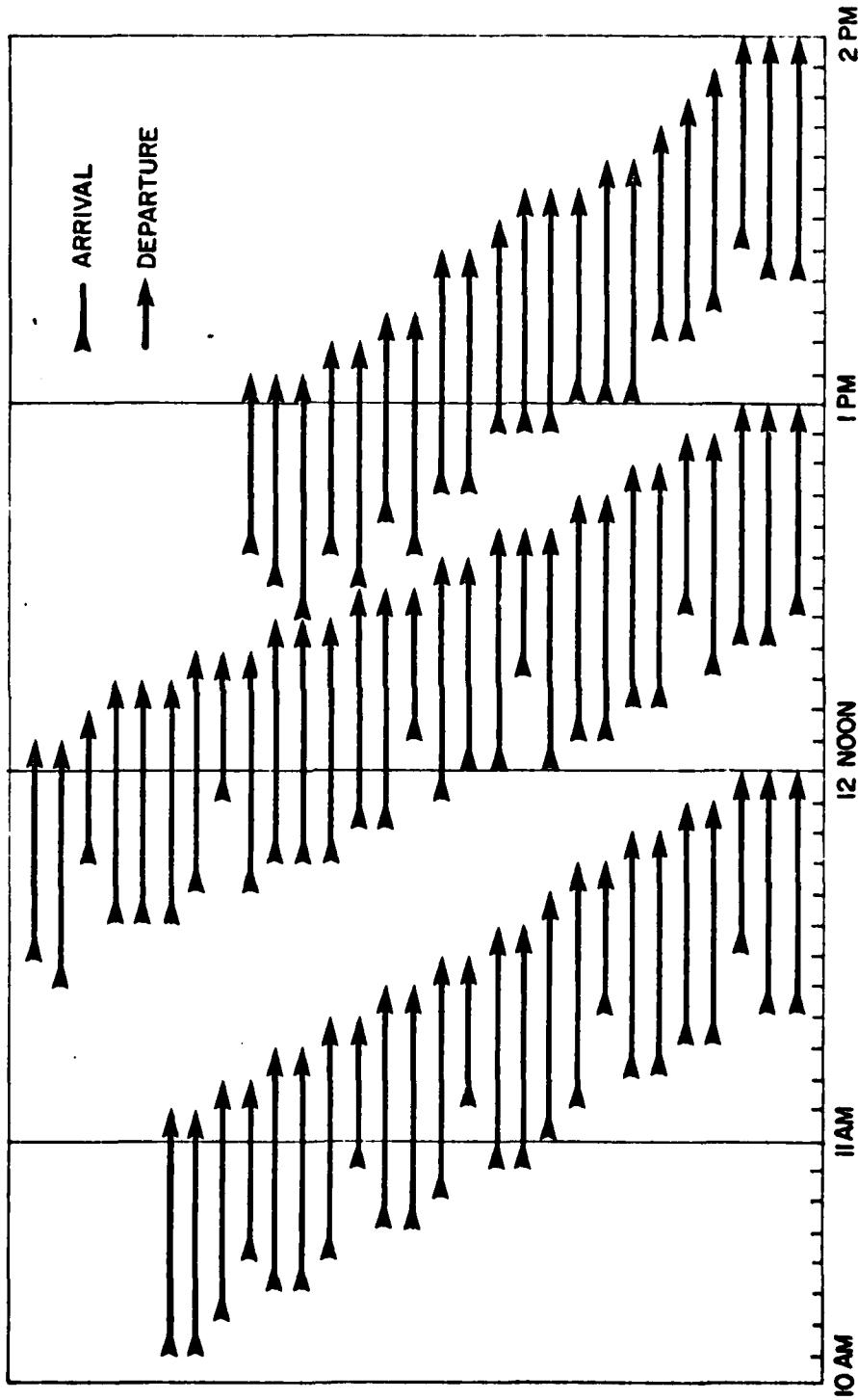
FIGURE 3

WASHINGTON NATIONAL AIRPORT
Distribution of Scheduled Arriving Flights
During the Hour 8:00 AM to 8:59 AM
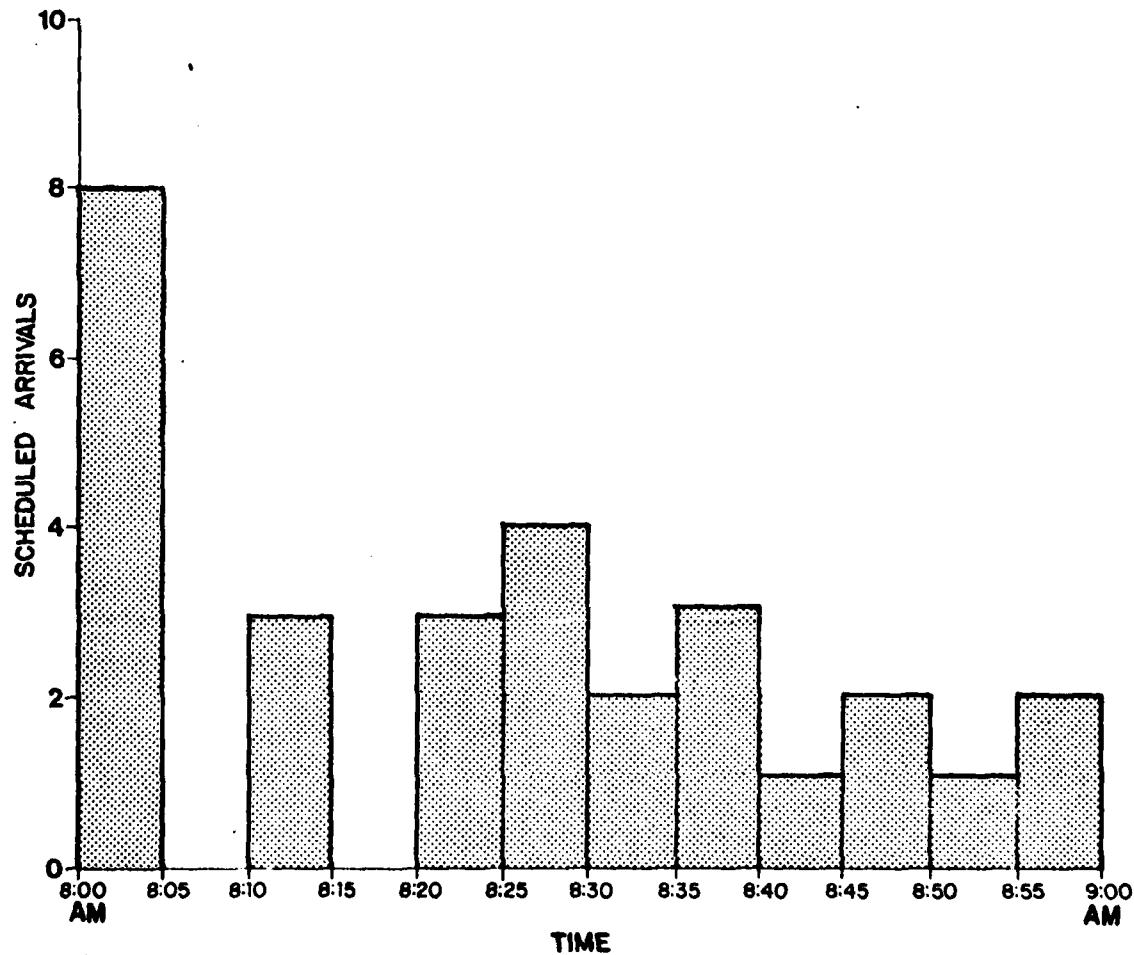
V. Investment Data Base

Basic unit costs were developed, to the degree of
detail practical, for use in this study. The unit
costs were derived from a variety of sources in-
cluding but not limited to comparable airport
construction nationwide, previous studies, Mean's
Building Construction Cost Data, and current con-
struction projects at Baltimore-Washington Inter-
national Airport as well as Washington National
Airport.

The unit costs employed in this study are presented
in Table 5. In certain cases basic unit costs were
converted into units which can be more easily applied
and compared in the cost estimating process. For
example, square yardage costs for roadway pavements
were converted into costs per linear foot of roadway
for two and four lane roadway systems. Since this
study does not provide for any level of design of
facilities, certain designs were assumed (such as
pavement thickness) based on the detail available,
similar projects, and "standard" construction tech-
niques.

All of the basic unit costs include 15 percent for
contingencies, 20 percent for contractor overhead
and profit, and 6 percent for architectural and
engineering fees. All costs are in 1976 dollars.

These unit costs were brought up-to-date by applying

UNIT COSTS (1976 DOLLARS)

	Narrow-Body	Wide-Body
1. **Airside**		
- Loading Bridges		
Standard	$ 90,000	$120,000
Telescoping	$150,000	$215,000
- Pavement		
Apron [1]/	$ 40.00/S.Y.	$ 40.00/S.Y.
Filleting	---	$353,200 L.S. [2]/
- Transporters	$375,000	$375,000

2. **Terminal**

  - Baggage Handling Systems

    - Outbound (from ticket counter to make-up area)
    $270,000/Module (manual sortation) [3]/
    Each module accomodates up to six peak hour aircraft

    - Inbound
    $100,000/claim device
    Each device accomodates 2 peak hour aircraft

[1]/ Paving:

Site Preparation	$ 7.00
Base Course	5.75
Surface Course	8.50
Sealer	1.50
Drainage	2.75
Marking & Lighting	2.75
41% Mark-up	11.60
	$39.85 or $40.00/S.Y.

[2]/ 8,830 S.Y. @ $40.00/S.Y.

[3]/ Mechanized sortation is $375,000 per Module.

2. <u>Terminal</u> (Continued)

   - Shell costs: $40.00/S.F.

   - Public Areas: Passenger processing facilities,
     lounge areas, rest rooms, shops, etc., $50.00/S.F.
     plus shell.

   - Administrative Areas: Airline and airport offices,
     operations offices, Federal Aviation Administration
     offices: $40.00/S.F. plus shell.

   - Remodeling existing terminal: $80.00 S.F. total.

3. <u>Groundside</u>

	On-Grade	Structural
- Access		
Two Lane	$ 83/L.F. <u>1</u>/	$ 556/L.F. <u>2</u>/
Four Lane	$167/L.F.	$1,111/L.F.
- Auto Parking	$1,000/Space	$5,000/Space

<u>1</u>/$ 83/L.F.   = Two lane (25 foot total width) @ $30.00/S.Y.
  $167/L.F.   = Four lane (50 foot total width) @ $30.00/S.Y.

<u>2</u>/$556/L.F.   = Two lane (25 foot total width) @ $30.00/S.Y.
$1,111/L.F.   = Four lane (50 foot total width) @ $30.00/S.Y.

a 7 percent inflation factor to 1975 costs. This
inflation factor was considered to be somewhat
lower than experience of the past few years and
is a judgment by the consultants. The support for
this lower inflation factor is drawn from recent
experience of high engineering estimates as noted
in the items shown in Figure 4.

FIGURE 4

CONSTRUCTION COST INFLATION TRENDS

Denver airport job priced 22% below estimate

A contract for the improvement of a runway complex at Denver's Stapleton International Airport was awarded to Peter Kiewit Sons' Co., Omaha, with a $12,122,308 low bid that was 22% below the $15,450,937 estimate and 4% under the next lowest competitor.

1c Peter Kiewit Sons' Co., Denver, CO			$12,122,308	
2 Gordon H. Ball Inc., Danville, CA			$12,740,013	
8 Western Contracting Corp., Sioux City, IA			$15,487,670	
EE Denver Dept. of Public Works, Denver, CO			$15,450,937	

Bids Apr 21, 1976 Items	Unit	Quantity	Unit Price 1C	2
Phase I				
Asphalt removal	sy	58,839	0.25	0.40
Concrete removal	sy	4,406	1.25	2.00
Unclass excavation	cy	98,659	1.25	0.70

Engineering News Record, July 8, 1976, p. 47.

Tied-arch bridge bid 15% under estimate

The winner of a $11,662,660 contract for construction of a 780-ft-long steel tied-arch bridge over the Ohio River at Wheeling, W. Va., came in 15% beneath the engineer's $13,679,889 estimate in a field of seven bidders.

functional during construction of the bridge.

A concrete deck and approaches for the bridge will be let in a separate contract.

Engineering News Record, August 28, 1975, p. 40.

Hawaii viaduct bid cuts estimate by $3.7 million

Competition among four contractors for a 3,453-ft-long concrete viaduct in Honolulu resulted in a $16,866,380 contract that was 18% or $3,766,466 under the $20,632,846 estimate and 2.1% beneath the second low bid.

appurtenances, as well as 138 trees.

Some minimum hourly wage rates, including fringe benefits, are: laborers, $7.37; iron workers, $9.25; equipment operators, $9.58; and carpenters, $8.40.

1C Dillingham Corporation, Honolulu, Hawaii $16,866,380

Engineering News Record, August 28, 1975, p. 40.

Bid 23% under estimate takes bridge project

A New York City contractor priced a northern New Jersey bridge and paving job 23% below the engineer's $1,525,000 estimate and took the contract with a bid that was 4.3% beneath its closest competitor in a field of 11 bidders.

A 18 to 46-ft-wide roadway will parallel the river and require extensive shoring of the bank with steel sheet-piles.

1C JV Cayuga-Caycon Constructors, New York, NY ... $1,176,750
2 J. H. Reid, West Orange, New Jersey.................... 229,381
11 Diversified R & T. Const. Co., No. Brunswick,
New Jersey...1,597,436

Engineering News Record, August 7, 1975, p. 83.

All bids under estimate for San Francisco rail station

All five bidders for construction of a San Francisco Municipal Railway station and upgrading sections of trolley track dropped below the Bay Area Rapid Transit's $7,044,000 estimate. The low bidder took the job with prices totaling 10.4% or $726,637 under the estimate.

All bidders under estimate for Henry Hudson Parkway repair

All six bidders for rehabilitating a 1.75-mile-long section of viaduct on the Henry Hudson Parkway in New York City dropped below the state department of transportation's $13,528,788 estimate, and the low bidder took a $10,670,651 contract coming in 5.4% under its closest competitor.

Engineering News Record, June 24, 1976, p. 116. December 18, 1975, p. 84.

VI. Washington National Airport

A. AIRPORT FACILITIES

The most dramatic effect of the alternatives under
consideration would occur at National Airport. The
impact, in terms of investments, occurs based on two
factors, those being the investments required to equip
the airport to handle wide-body aircraft and the invest-
ment associated with expansion to meet increased levels
of demand. National Airport is currently one of the most
intensely utilized airports in the world today. Limita-
tions in available space have created significant con-
straints on the expansion of the airport and at the same
time political and community attitudes have acted to de-
ter major investment programs. Unfortunately, the demand
has continued to increase to the point that the terminal
now functions in what is, in esoteric terms, an oversatu-
rated condition. In common terms, this is a way of saying
that the terminal facilities are so crowded that the ser-
vice level to the passenger has dropped be'ow accepted
standards of the aviation industry. As a rule of thumb,
the airport terminal requires a gross floor area equiva-
lent to about 200 square feet per Typical Peak Hour Pas-
senger (T.P.H.P.). The passenger surge effect of wide-
body aircraft would increase this by about 10 percent
or 220 sq. ft. per T.P.H.P. The current terminal of ap-
proximately 600,000 square feet with a demand of about
2,510 T.P.H.P. 1/ is equivalent to 239 square feet per
passenger which is slightly above the standard. However,
certain facilities within the terminal are inadequate
to meet the demand. Specifically identified are: gate
positions (of the 42 officially designated gates only 35 are

1/ 1,506 P.H. Enplanements + 0.60 directional in balance =
   2,510 T.P.H.P. (Source - CAB Data, May, 1975).

positions at the terminal); the baggage claim devices
are considered inadequate; the passenger flow areas
constrict passenger movement; the curb space is divided
forcing passengers to cross as much as three lanes of traf-
fic;and the parking spaces are inadequate. Thus the ini-
tial step in analyzing the investment requirements in-
volved an analysis of costs associated with bringing the
current facilities up to more acceptable standards. It
should be noted that National functions differently in
character from other airports and thus not all criteria
used for standard design is applicable; instead through
varying sources of information, the specific needs of the
passengers at National were used in the investment analysis[1]/
The current terminal facilities are discussed in the follow-
ing three areas: Airside, Terminal and Groundside.

Figure 5 depicts the present terminal configuration and
ground access facilities as well as some conceptual de-
velopment features. Figures 6a and b illustrate a basic
terminal expansion concept utilized for this analysis.
An effort was made to utilize the most standard form of
expansion which would be compatible and functional at
National and meet the demand requirements. At present the
terminal at National (Main and North Terminals) is in need
of major remodeling and for this analysis it was estimated
that such a remodeling effort would involve about 300,000
square feet and would accomplish such features as receiving
passengers from an elevated roadway and improved passenger
circulation. It should be noted that some remodeling is
currently planned by the airlines; however, this focuses
primarily on the hold room and gate areas.

[1]/The high ratio of business travelers produces lower than
  normal baggage per passenger, passenger arrival times
  nearer flight departure times etc. Also, the ratio of
  originating vs. connecting passengers is higher.

Two other facilities at National were checked in relation
to this study: firstly the present apron areas around the
terminal and general airfield operating surfaces were re-
viewed in terms of adequacy to accommodate wide-body

FIGURE 5

WASHINGTON NATIONAL AIRPORT
Existing and Conceptual Facilities

NORTH
1" = 550'

●●●● METRO SYSTEM

==== POSSIBLE ELEVATED ROADWAY

38 EXISTING AIRCRAFT GATES
● EXISTING AIRCRAFT GATES

Main Terminal
Possible Parking Structure Location
Hangars
Conceptual Pier Location
North Terminal
Conceptual Pier Location
Commuter/General Aviation Terminal
Hangars

-27-

Key

BOARDING DEVICE	**1**
PUBLIC CORRIDOR	**2**
DEPARTURE LOUNGE SECOND LEVEL	**3**
SECURITY FACILITIES	**4**
OPERATIONS GROUND LEVEL	**5**

CONNECTOR – PIER CONCEPT

Source: Department of Transportation, FAA, Systems Research &
        Development Service, Washington, D.C., July, 1975.

FIGURE 6

Terminal

Key

BOARDING DEVICE	**1**
PUBLIC CORRIDOR	**2**
DEPARTURE LOUNGE	**3**
SECURITY FACILITIES	**4**
AIRLINE OPERATIONS BELOW DEPARTURE LOUNGE	**5**
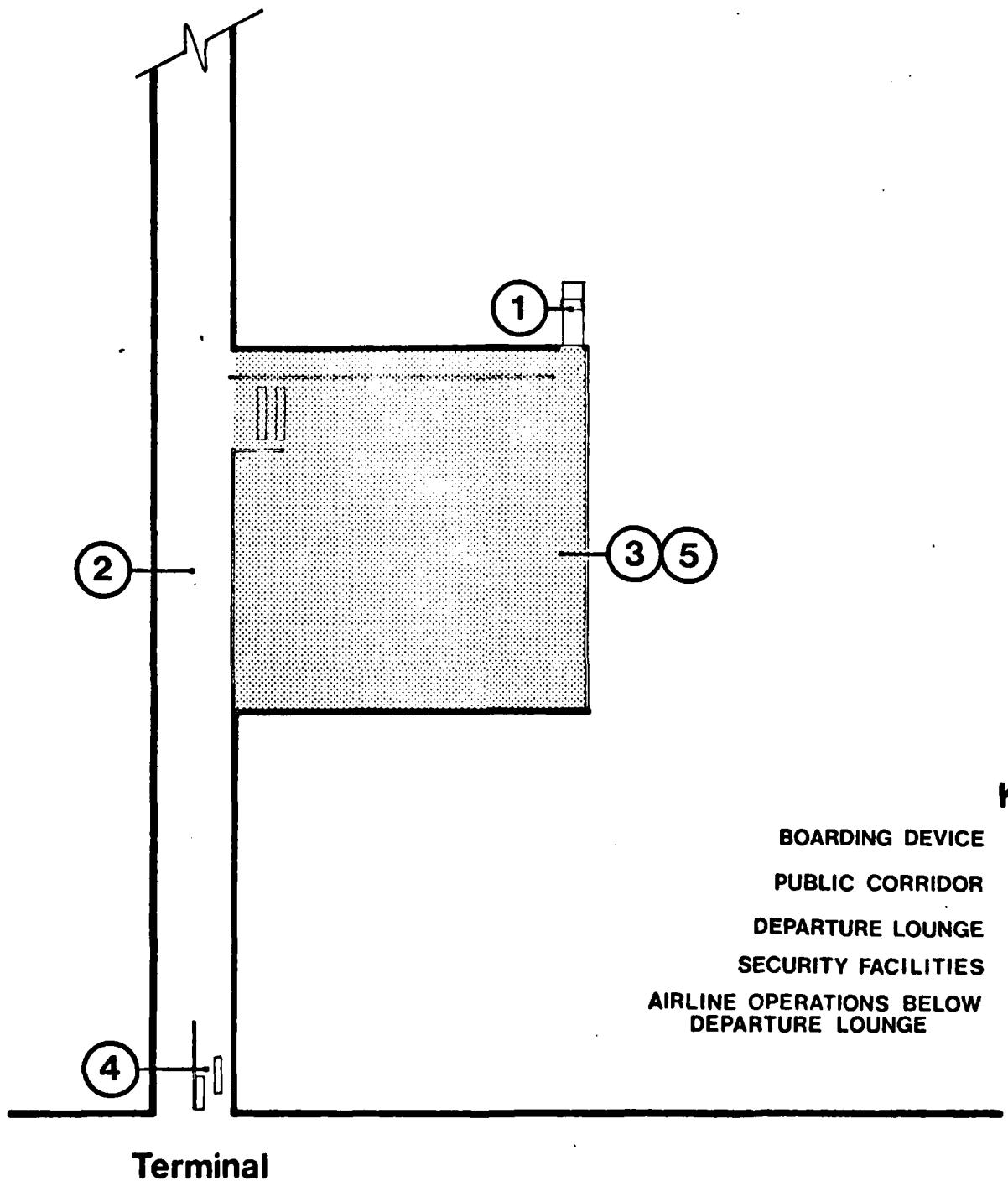
CONNECTOR – PARTIAL PLAN

Source: Department of Transportation, FAA, Systems Research & Development Service, Washington, D.C., July, 1975.

aircraft and it was determined that increasing the fillets
would be the only significant change necessary; secondly
the Crash Fire and Rescue capabilities to handle large
aircraft was reviewed and it was determined that any expense
of meeting such needs would be minimal.

Airside: There are 42 gate positions at Washington
National Airport, of which 32 are at the Main Terminal
and the remaining 10 are at the North Terminal.
Allegheny, American, Eastern, Northwest, TransWorld
and United comprise the Main Terminal airline tenants
with Braniff, Delta, National and Piedmont occupying
the North Terminal.

The following gates at the Main Terminal can accommo-
date wide-bodied aircraft without a loss in total
positions:

Gates 1,3,5,7 .... Northwest, TWA finger
Gates 9,14........... American Airlines finger
Gates 20,23.......... Eastern Airlines
Gate 24.............. United Airlines

Thus, there are a total of 9 gate positions for use
by wide-bodied equipment that would not affect the
total of 42 positions. Servicing a wide-body air-
craft at the North Terminal would require approxi-
mately two gate positions per aircraft. It should
be noted that the use of wide-body aircraft on the
airfield would require about 8,800 square yards of
additional pavement in the fillets.

Terminal Areas: The Washington National Airport terminal
complex consists of three elements: the Main Terminal,
the North Terminal and the Commuter Airline and General
Aviation Terminal. The Main Terminal and the North Ter-
minal are connected. However, the Commuter/General Avia-
tion Terminal is a separate facility located approximate-
ly 1,000 feet northwest of the North Terminal. The total
square footage of the complex is 607,150 square feet. A
detailed inventory of the square footage and function is
presented in Table 6.

The introduction of wide-body aircraft will affect the
terminal requirements in a number of ways. The primary
causal feature of wide-body requirements in the terminal
is the surge of passengers generated by the arrival of the
aircraft (the surge effect of a departing wide-body is not
so pronounced). This surge of passengers would tend to con-
gest corridors and specifically the baggage claim areas. In
most cases the airline baggage claim devices are only one
half the size recommended to serve wide-body aircraft.

As general guidelines for determining future terminal area
requirements at National Airport, the FAA guidelines men-
tioned earlier of 200 sq. ft. per T.P.H.P., increased 10
percent when wide-body aircraft were introduced, were
checked with the standard area requirements per gate. These
requirements established for the FAA and published in
The Apron & Terminal Building Planning Manual suggest a
range of 15,000 - 17,000 square feet per gate for an air-
port with the number of enplanements as National. This
checks favorably with the current conditions and thus
was also utilized; the low range was used when no wide-
body aircraft were involved and the high range was used
for wide-body aircraft gates.

Table 6

TERMINAL AREA INVENTORY

Component	Main Terminal	North Terminal	Subtotal	Commuter Terminal	Total
Ticketing Areas	26,500	9,400	35,900	1,250	37,150
Public-Concourse Related	82,250	8,600	90,850	-0-	90,850
Public-General	70,100	6,050	76,150	8,500	84,650
Passenger Departure Areas	57,350	16,000	73,350	800	74,150
Airline Operations	97,600	15,250	112,850	7,200	120,050
Baggage Claim Areas	10,650	2,100	12,750	-0-	12,750
Baggage Make-up & Breakdown Areas	48,250	4,750	53,000	-0-	53,000
Concessions	46,550	2,900	49,450	350	49,800
Building Services	76,450	650	77,100	7,650	84,750
Totals	515,700	65,700	581,400	25,750	607,150

In a general sense about one half of the current terminal space is in need of major remodeling including HVAC and electrical systems.

The total baggage claim frontage available in the terminal is
695 linear feet. In effect, each airline operating at National
Airport has its own baggage claim area (or device). It was
assumed that this practice will be continued in the future.
In developing the baggage claim device requirements for this
exclusive system, it was only necessary to distinguish those
modes permitting wide-body operation versus those that do not.
The critical peaking factor is not the total peak hour, but
each individual peak hour. In any given peak hour in any
given mode, it is assumed that each airline would have two
arrivals within a 15-20 minute span. Therefore, the require-
ments are based on the claim frontage needed for two narrow-
bodies (baseline, Case 2 and Case 6) or one narrow-body and
one wide-body (Cases 13 and 17). It is assumed that
all of the airlines, with the exception of Allegheny, Piedmont
and the commuters, will be candidate to require the ability to
accommodate wide-bodies. The results of this analysis are found
in Table 7.

Table 7

BAGGAGE CLAIM FACILITIES

| Airline | Existing | LINEAR FEET OF CLAIMING FRONTAGE [1] | | | |
| | | Without Wide Bodies (Baseline, Cases 2 & 6) | | With Wide Bodies (Cases 13 & 17) | |
		Total	New	Total	New
Piedmont	25	100	75	N/A	N/A
National	100	100	0	175	75
Braniff	0	100	100	175	175
Delta	65	100	35	175	110
United	100	100	0	175	75
Eastern	100+ 40 for Shuttle	100+ 40 for Shuttle	0	175	35
Allegheny	45	100	55	N/A	N/A
American	90	90	0	175	85
TWA	65	100	35	175	110
Northwest	65	100	35	175	110
Commuters[2]	0	50	50	N/A	N/A
TOTALS	695	1080	385	1650	955

[1] Based on 1.3 average bags per passenger.

[2] Commuters currently in their own terminal but it is assumed that they would relocate to Main or North Terminal if adequate space was provided.

Groundside: The capacities of the groundside system serving National Airport are presented in three components - access, curbside and automobile parking facilities.

The access roadway capacity shown below reflects the capacity of the new one-way road scheme scheduled for completion in late 1976. The hourly vehicular capacity of the airport's three major entrance/exit points, based on the 1965 Highway Capacity Manual (Special Report Number 87) and a "D" service level, which is a typical design level for urban streets, is presented in the table below:

Access Road	Peak Hour Capacity
Smith Boulevard North	2,025
Route 233 Viaduct	1,100
Smith Boulevard South	350

The public auto parking facilities can be classified into three categories - short term (metered parking), medium term (Lots 1,2,3 and 4 - all within walking distance to the terminal), and long term (Lot 5, which is referred to as satellite parking). The capacities of these facilities are listed below:

Facility	Capacity (approximate)
Metered Parking	200
Lots 1, 2, 3 and 4	2,500
Satellite Parking	1,000
Total	3,700

Employee parking (3200 spaces) is well distributed throughout the airport.

There is a total of 2,000 linear feet of curb frontage available for private automobiles. The Main Terminal has 1,500 feet curbside and the North Terminal has 500 feet of curb frontage.

B. COST ESTIMATES FOR WASHINGTON NATIONAL TO
   MEET CURRENT NEEDS

Upgrading the current facilities at National Airport
was considered as a basic cost which would be incurred
independent of the policy determination. This realism
is evident in the fact that expansion plans are current-
ly being prepared by many of the airlines and prior
consultant studies have been funded to determine possible
improvements to the ground access. Also, a request is
currently being considered to design a parking structure.

The following standards and facilities were determined
and analyzed for investment requirements of the current
demand.

Airside: Of the current 42 aircraft positions at the
airport (discounting commuters), 7 are not "at terminal"
positions but instead require that passengers walk across
the apron to board the aircraft. Therefore adequate space
for 7 more terminal positions should be provided. Standard
loading bridges at these positions require an investment
of about $90,000 each or $630,000.

Terminal: An additional 120,000 square feet of space,
probably associated with the seven aircraft positions
mentioned above plus some currently planned widening of
the northern extension of the Main Terminal, would pro-
vide for the current need for additional facilities. 1/
Associated with this would be at least one additional
complete baggage handling system (Outbound and In-
bound). In addition about 50 percent of the exist-
ing terminal space needs major remodeling. These costs

1/ Estimated space requirements per gate is 15,000
   sq. ft. (Source: The Apron and Terminal Building
   Planning Manual - R.M. Parsons, July 1975) and
   15% was added to improve the constriction in the
   Northern end of the Main Terminal.

are itemized below:

- Additional space
  - 120,000 sq. ft. shell = $ 4,800,000
  - 60,000 sq. ft. public areas 3,000,000
  - 30,000 sq. ft. administrative = 1,200,000
    - Subtotal $9,000,000
- Additional baggage system
  - Outbound $ 270,000
  - Inbound 100,000
    - Subtotal $ 370,000

- Remodeling
  - 300,000 sq. ft. = 24,000,000

    Total Terminal Areas = $33,370,000

Groundside: The current access roadway is inadequate
both in capacity and in providing curb space for pas-
senger use. The basic concept therefore assumes a two lane
elevated roadway passing along the Main Terminal for
a distance of about 1,600 linear feet and containing
a segment four lanes wide for a distance of 800 feet.
In addition, based upon data presented in a recent ac-
cess study for National Airport and studies on parking
demands at LaGuardia, it was assumed that public park-
ing spaces equivalent to one space per each one thous-
and annual originating enplaned passengers should be
provided at National. Therefore, an additional 1,300
spaces are needed to serve the current demand (based
on 5 million annual originating enplanements).

1/ Washington National Airport: Interim Access Improvement
   Program; HNTB, August 1973.

The costs for these groundside improvements are
estimated as follows:

- Elevated Roadway

800 feet of two lane roadway	= $	444,800
800 feet of four lane roadway	=	889,600
Ramps 800 feet, two lane	=	444,800
Subtotal		$1,779,200

- Parking Structure

1,300 spaces	=	$6,500,000
Total Groundside		$8,279,200

The total investment required to meet the current
demand can then be summarized as follows:

Current Demand Cost Summary

- Airside	$ 630,000
- Terminal	33,370,000
- Groundside	8,279,200
	$42,279,200

Based upon the analysis of the 1990 demand forecasts the follow-
ing basic facility requirements were projected (see Appendix for
detailed calculations).:

CASE 2 - 1990 COST ANALYSIS

Airside:

- 49 gates required, none for wide-body aircraft
- Requires 14 new positions at the terminal building 9 of
  which would be equipped with standard loading bridges
  (5 are for commuter aircraft and no loading bridges are
  provided.)
  Cost:
  > 9 bridges @ $90,000 = $810,000.

Terminal:

- 673,000 sq. ft. required based on T.P.H.P.
- 735,000 sq. ft. required based on number of gates.
- Requires two additional baggage handling systems.
- Assumes remodeling of 300,000 sq. ft. of existing
  terminals.
  Cost:

- 128,000 sq. ft. (735,000-607,000)		
100% shell @ $40/S.F.	=	$5,120,000
50% Public @ $50/S.F.	=	3,200,000
25% Administrative @ $40/S.F.	=	1,280,000
Subtotal 1/		$ 9,600,000
- 300,000 sq. ft. remodel @ $80/S.F.	=	$24,000,000
- Baggage handling, 2 systems		
Outbound	=	$ 540,000
Inbound	=	200,000
Subtotal	=	$ 740,000
.Total Terminal Area	=	$34,340,000

Groundside:

- Elevated roadway as required to meet the current needs
  is considered to provide adequate access and curb
  facilities.

1/ Assumes 25% of space unfinished for HVAC, Mechanical and
Electrical Space and so forth.

- Parking for 5.8 million annual enplanements requires
  approximately 2,100 (5,800 - 3,700) additional spaces;
  all are assumed to be provided in a parking structure.

Cost:
- Elevated Roadway

    800 feet of two lane @ $556/L.F. = $ 444,800

    800 feet of four lane @ $1111/L.F.=   889,600

    800 feet of two lane ramp @ $556/L.F.= 444,800

    Subtotal $1,779,200

- Parking Structure

    2,100 spaces @ $5,000/Space   =$10,500,000

  Total Groundside   =$12,279,200

CASE 2 COST SUMMARY:

Airside	=	$ 810,000
Terminal	=	34,340,000
Groundside	=	12,279,200
TOTAL	=	$47,429,200

CASE 6 - 1990 COST ANALYSIS

Airside:
- 33 gates required, none for wide-body aircraft
- Requires no new gates or loading bridges
  Cost: (None)

Terminal: ·
- 398,000 sq. ft. required based on T.P.H.P.
- 495,000 sq, ft. required based on number of gates
- Requires no expansion and would suggest that only 118,000 sq. ft. of the existing terminal would require remodeling.
  Cost:
    - 188,000 sq. ft. remodeled @ $80/S.F. = $15,040,000

Groundside:
- Elevated roadway is estimated to require two lane section only,for about 1600 feet plus ramps.
- Parking for 2.9 million annual originating passengers can be met by the existing parking facilities.
  Cost:
    - Elevated roadway
        1600 feet of two lane @ $556/L.F.   = $889,600
        800 feet of two lane ramp @ $556/L.F.= 444,800
                                               $1,334,400

CASE 6 COST SUMMARY:

Airside	=	(None)
Terminal	=	$15,040,000
Groundside	=	1,334,400
TOTAL	=	$16,374,400

CASE 13 - 1990 COST ANALYSIS

Airside:

- 52 gates required, 13 gates capable of serving wide-body aircraft. For this mode it was assumed that the nine gates and two loading bridges capable of serving wide-body aircraft would be used. In addition 17 gates would be provided through a terminal expansion project, at least four of which would be capable of serving wide-body equipment.
- The additional loading bridges are expected to include four new telescoping bridges to serve wide-body aircraft and 13 standard, to serve narrow-body planes. In addition seven of the nine existing gates with wide-body handling capability will require a conversion of the loading bridges to handle wide-body aircraft.
- Additionally the taxiway fillets on the airfield must be enlarged to accomodate the larger aircraft. The total requirements are 8,830 square yards of additional pavement. Cost:
    - Loading bridges

7 converted to wide body @ 30,000	=	$ 210,000
4 new Telescoping @ $215,000	=	860,000
13 standard for narrow-body @ $90,000	=	1,170,000
Subtotal	=	$2,240,000
Fillets 8,830 sq. yd. @ $40/S.Y.	=	353,200
Total Airside	=	$2,593,200

Terminal:

- 824,000 sq. ft. required based on T.P.H.P.
- 806,000 sq. ft. required based on number of gates.
- Requires the equivalent of 7 additional baggage handling systems for wide-body use.
- Assumes remodeling of 300,000 sq. ft. of existing terminal space.

Cost:
- 217,000 sq. ft. new terminal

100% shell @ $40/S.F.		=	$ 8,680,000
50% public @ $50/S.F.		=	5,425,000
25% administration @ $40/S.F.		=	2,170,000
Subtotal 1/		=	$16,275,000

- Remodeling 300,000 sq. ft @ $80/S.F.   =   24,000,000
- Baggage handling, 7 systems

Outbound	=	1,890,000
Inbound	=	700,000
Subtotal	=	$ 2,590,000
Total Terminal	=	$42,865,000

Groundside:

- An elevated roadway is assumed and it is estimated that a four lane segment will be required the full length of the main terminal section, 1600 linear feet, plus two ramps each 400 feet in length.
- Parking facilities for the 6.8 million annual originating passengers is assumed to require structural parking for 3,100 (6,800 - 3,700) autos.

Cost:
- Elevated Roadway

1600 feet of four lane @ $1111/L.F.	=	$ 1,779,200
800 feet of two lane ramp @ $556/L.F.	=	444,800
Subtotal	=	$ 2,224,000

- Parking Structure

3100 spaces @ $5,000/Space	=	$15,500,000
Total Groundside	=	$17,274,000

CASE 13 COST SUMMARY

Airside	=	$ 2,593,200
Terminal	=	42,865,000
Groundside	=	17,724,000
TOTAL	=	$63,182,200

1/ Assumes 25% of space unfinished as noted previously.

CASE 17 - 1990 COST ANALYSIS

Airside:
- 45 gates required, 13 gates capable of serving wide-body aircraft. For this mode it was assumed that the nine gates identified earlier as being capable of handling wide-body aircraft would be used. One additional wide-body gate can be provided by using two of the gates at the North Terminal. This leaves a need for 13 new gate positions of which at least three should be able to accomodate wide-body planes.
- Loading bridges at 8 of the 10 existing gates to be used for wide-bodies must be converted for their use. Of the new gates, 3 should be equipped with telescoping loading bridges for wide-body aircraft and the remaining 10 can be standard narrow-body aircraft service type.
- Additionally, taxiway fillets must be enlarged on the airfield for use by wide-body aircraft. The requirement for pavement in these fillets is estimated at 8,830 square yards.

  Cost:
  - Loading Bridges

10 converted for wide-body use @ $30,000	= $	300,000
3 new telescoping @ $215,000	=	645,000
10 new standard for narrow body use @ $90,000	=	900,000
Subtotal	=	$1,845,000
- Fillets 8,830 sq.yds. @ $40/S.Y.	=	353,000
Total Airside	=	$2,198,000

Terminal:
- 719,000 sq. ft. required based on T.P.H.P.
- 701,000 sq. ft. required based on number of gates,
- Requires the equivalent of 6 additional baggage handling systems to serve wide-body aircraft plus additional gate positions.

- Assumes 300,000 sq. ft. of the existing terminal must
  be remodeled.
  Cost:
    - 112,000 sq. ft. new terminal

100% shell @ $40/S.F.	=	$ 4,480,000
50% public @ $50/S.F.	=	2,800,000
25% administrative @ $40/S.F.	=	1,120,000
Subtotal 1/	=	$ 8,400,000

- Remodeling 300,000 sq.ft. @ $80/S.F. = 24,000,000
- Baggage handling, 6 systems

Outbound	=	1,620,000
Inbound	=	600,000
Subtotal	=	$ 2,220,000
Total Terminal	=	$34,620,000

Groundside:
- An elevated roadway is assumed necessary and is estimated
  to require four lanes of pavement for a 1,600 foot segment
  along the main terminal. An additional 800 feet of two
  lanes will be required in the ramps.
- The 7.0 million annual originating passengers are estimated
  to require 3,300 (7,000 - 3,700) new parking spaces in a
  parking structure.
  Cost:
    - Elevated Roadway

1600 feet of four lane @ $1111/L.F.	=	$ 1,779,200
800 feet of two lane ramp @ $556/L.F.	=	444,800
Subtotal	=	$ 2,224,000

    - Parking Structure

3,300 spaces @ $5000/Space	=	16,500,000
Total Groundside	=	$18.724,000

1/ Assumes 25% of space unfinished as noted previously.

CASE 17 COST SUMMARY

Airside	=	$ 2,198,000
Terminal	=	34,620,000
Groundside	=	18,724,000
TOTAL	=	$55,542,000

VII. Baltimore – Washington International Airport

A $64.5 million terminal remodeling program, which will
be completed in 1978, is underway at the Baltimore-Washington
International Airport. The design for the new terminal will
provide approximately 700,000 square feet of terminal area and
26 aircraft gates. The airport also operates two transporters
(Plane-Mates). The design capacity of the expanded terminal is
11.2 million annual passengers. This is equivalent to approxi-
mately 3,500 passengers during a typical peak hour. The required
gate positions will be determined by the gates per peak hour de-
parture relationships established in the analysis of National Air-
port.

For the purpose of analyzing alternative system
concepts, the following data and assumptions were used:

- Terminal area requirements
    - 15,000 to 17,000 square feet per gate
    - 220 square feet per T.P.H.P.
- Cost per square foot of terminal: $92.00 (including
  all terminal related items; e.g. roadway, baggage
  handling system, loading bridges, etc.)

BWI's facility requirements, based on the demand
presented in the DEMAND PROFILE Chapter, are summarized in the
following table (see Appendix for detailed calculations):

TERMINAL REQUIREMENTS

| CASE | Current Program | | Terminal Requirements | | |
	Terminal S.F.	No of Gates [1]	S.F. Based On T.P.H.P.	S.F. Based on Gate Requirements	No of Gates [2]
2	700,000	26	552,000	690,000	44
6	700,000	26	609,000	705,000	45
13	700,000	26	572,000	690,000	44
17	700,000	26	575,000	705,000	45

1/ The airport also operates two transporters (Plane-Mates).
2/ All modes require 15 wide-body gates.

It should be pointed out that in no case do the projections in this analysis exceed the annual or peak hour passenger design levels employed in the current construction program. As can be seen from the above table, the planned terminal square footage will adequately satisfy the projected demand. The airport may require some additional gates or transporters. However, the projected gate requirement may be met by joint use (or common use) of gates. For example, the calculations in the table are based on a 60 percent gate occupancy factor. If the factor can be increased to 90 percent then no additional gates will be needed. In fact, the State of Maryland has standardized all functional installations throughout the holdrooms and gate positiona to provide flexibility in common utilization of facilities when needed. Therefore, the current program of $64.5 million will be adequate to accommodate the future demand in all of the five modes studied.

VIII. Dulles International Airport

The Dulles Airport passenger terminal is vastly different from National in concept and utilization patterns. At Dulles, the 188,000 square feet of passenger access area constitutes 63 percent of the total terminal area (300,000 square feet). The combination of transporters and ground level passenger gates is the primary factor permitting the more favorable length to width relationship and a more uniform distribution of people throughout the terminal. The initial design (1964) contemplated about 224 square feet per T.P.H.P. for gross terminal area. These areas compare very closely with the FAA's terminal requirements standards issued in 1967 for conventional terminal concepts. Experience with the terminal has generally indicated a capability of greater efficiency to the point that 170 square feet per T.P.H.P. appears more reasonable. 1/

The use of the transporter concept eliminates, to a large extent, the concern for aircraft positioning at terminal gates. Terminal gates are, however, needed to serve the smaller aircraft (30-95 seats). The larger aircraft plus some of the 95 seat configuration can be served by the transporters. The number of transporters that will service a specific aircraft will be determined to a large extent by the size of the aircraft, the boarding load factor, and the type of transporter.

The cost of expansion of the Dulles terminal will depend to a large extent upon the type of construction. The increase in terminal space requirements expected in the

1/ National Capital Airports, by James Wilding, 1972.

future justify some deviation from the current terminal
concept. Previous analyses of the terminal reflecting
this very consideration are utilized in this study.[1] The
future terminal expansions at Dulles are therefore pro-
jected to occur in two forms, the "main terminal" concept,
and a "low profile" concept. The "main terminal" concept
is merely an extension of the current type of terminal
building. Some additional space can be accommodated in a
"low profile" terminal concept which would serve primarily
the deplaning passengers. These concepts afford savings in
costs as well as providing aesthetic variation possibilities
for the future terminal design.

The present concept and low profile expansion are
estimated at $111 per square foot and $93 per square
foot respectively in 1976 constant dollars. The cost
of a new transporter is estimated at $535,000.

[1]/References: Dulles International Airport Master Plan
                 Report; FAA, 1964.

                 The Future of Washington's Airports;
                 Metropolitan Washington Council of
                 Governments, 1975.

For the purpose of the comparative analyses, the following data are utilized in this study for Dulles:

- Present gross terminal area = 300,000 square feet
- Transporter docking space = 24 spaces
- Terminal gates = 10
- Aircraft parking positions (Jet Ramp) = 30
- Automobile parking spaces = 3,400
- Transporters = 33 (21 mobile lounges and 12 Plane-Mates)
- Gross terminal area per T.P.H.P. = 170 square feet
- Transporters, aircraft parking positions and terminal gate utilization:

Aircraft Size	Transporters Per Peak Hour Departure 1/		Gates or Aircraft Parking Positions Per Peak Hour Departure 2/
	50-80 Passenger Capacity 3/	85-120 Passenger Capacity 4/	
95 seats or less	1	1	1.50
125	2	1	1.72
200	3	2	2.17
250	4	3	2.50
350	5	4	3.11

1/ To account for possible low average utilization per vehicle in the transporter operations due to airline schedule imbalances and to allow flexibility for such things as equipment down time, a spare transporter should be available for each five in operation.

2/ Assumes 60 percent gate occupancy factor.

3/ Older mobile lounge capacity.

4/ New Plane-Mate capacity.

Using the demand presented in Tables 4a - 4e the
requirements for Dulles International Airport are
summarized below (detailed calculations are present-
ed in the Appendix).

CASE	Terminal Space (S.F.)			Total Trans-porters	Total A/C Parking Po-sitions or Gates	Total Auto Parking Spaces
	Main 1/ Terminal	Low Profile	Total			
2	480,000	203,000	683,000	54	46	6,800
6	480,000	532,000	1,012,000	65 2/	84	12,700
13	480,000	200,000	680,000	56	52	5,100
17	480,000	187,000	667,000	56	52	7,500

1/ Includes constant 300,000 S.F. existing space.
2/ In Case 6, the peak hour in terms of passenger
   enplanements (or deplanements) does not coincide
   with the peak hour in terms of aircraft departures
   (or arrivals) as explained in the section on
   DEMAND PROFILE).

The cost of the additional facilities required is
detailed in the Appendix and summarized in the
table below:

CASE	Terminal 1/ Building ($ Millions)	Transporters and Apron 2/ ($ Millions)			Auto 3/ Parking ($ Millions)	Total ($ Millions)
		T.P.*	+Apron	Tot.		
2	38.9	7.9	2.4	10.3	6.8	56.0
6	69.5	12.0	11.5	23.5	12.7	105.7
13	38.6	8.6	3.8	12.4	5.1	56.1
17	37.4	8.6	3.8	12.4	7.5	57.3

*T.P. (Transporters)

1/ All modes include $20.0 million for Main Terminal
   construction. Difference is all for low profile
   construction.

2/ All new transporters are assumed to be the larger
   Plane-Mate type equipment.

3/ Future auto parking is assumed to be all on-grade.

IX. Appendix

WASHINGTON NATIONAL AIRPORT
CALCULATIONS

1990   DCA   SUMMARY OF TERMINAL BUILDING REQUIREMENTS
                        (BASED ON T.P.H.P. FACTOR)

CASE	TOTAL 1/ REQUIREMENTS (S.F.)	NEW CONSTRUCTION REQUIRED (S.F.)
2	673,000	66,000
6	398,000	None
13	824,000	217,000
17	719,000	112,000

1/ Square footage of existing terminal building
    (including Main, North and Commuter Terminals) =
    607,000 S.F.

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1990   DCA   CASE 2

Terminal Square Footage

Gross Terminal Area   = T.P.H.P. x utilization factor
                                   = 3,365 x 200 S.F./T.P.H.P.
                                   = 673,000 S.F.

Total New Construction = Gross Area - Existing Area
                                   = 673,000 S.F. - 607,000 S.F.
                                   = 66,000 S.F.

1990   DCA   CASE 6

Terminal Square Footage

Gross Terminal Area   = T.P.H.P. x utilization factor
                                   = 1,992 x 200 S.F./T.P.H.P.
                                   = 398,000 S.F.

Total New Construction = Gross Area - Existing Area
                                   = 398,000 S.F. - 607,000 S.F.
                                   = None

Terminal Square Footage

Gross Terminal Area   = T.P.H.P. x utilization factor
                        = 3,745 x 220 S.F./T.P.H.P.
                        = 824,000 S.F.

Total New Construction = Gross Area - Existing Area
                        = 824,000 S.F. - 607,000 S.F.
                        = 217,000 S.F.

1990   DCA   CASE 17

Terminal Square Footage

Gross Terminal Area   = T.P.H.P. x utilization factor
                        = 3,267 x 220 S.F./T.P.H.P.
                        = 719,000 S.F.

Total New Construction = Gross Area - Existing Area
                        = 719,000 S.F. - 607,000 S.F.
                        = 112,000 S.F.

1990   DCA   SUMMARY OF TERMINAL BUILDING REQUIREMENTS

(BASED ON GATE REQUIREMENTS)

CASE	TOTAL 1/ REQUIREMENTS (S.F.)	NEW CONSTRUCTION REQUIRED (S.F.)
2	735,000	128,000
6	495,000	None
13	806,000	199,000
17	701,000	94,000

1/ Square footage of existing terminal building (including Main, North and Commuter Terminals) = 607,000 S.F.

1990   DCA   CASE 2

Terminal Square Footage based on Gate Requirements

No. of Narrow-Body Gates x 15,000 S.F./Gate   = Terminal Area Requirements

        49 Gates   x 15,000 S.F./Gate   = Terminal S.F.

                                        = 735,000 S.F.

No. of Wide-Body Gates x 17,000 S.F./Gate   = Terminal S.F.

        0 Gates   x 17,000 S.F./Gate   = Terminal S.F.

                                        = 0 S.F.

            Total Terminal Required   = 735,000 S.F.

1990   <u>DCA</u>   <u>CASE 6</u>

<u>Terminal Square Footage based on Gate Requirements</u>

No. of Narrow-Body Gates x 15,000 S.F./Gate   = Terminal Area Requirement

33 Gates   x 15,000 S.F./Gate   = Terminal S.F.

= 495,000 S.F.

No. of Wide-Body Gates x 17,000 S.F./Gate   = Terminal S.F.

0 Gates   x 17,000 S.F./Gate   = Terminal S.F.

= 0 S.F.

Total Terminal Required = 495,000 S.F.

1990   DCA   CASE 13

Terminal Square Footage based on Gate Requirements

No. of Narrow-Body Gates x 15,000 S.F./Gate = Terminal Area Requirements

39 Gates   x 15,000 S.F./Gate = Terminal S.F.

= 585,000 S.F.

No. of Wide-Body Gates x 17,000 S.F./Gate = Terminal S.F.

13 Gates   x 17,000 S.F./Gate = Terminal S.F.

= 221,000 S.F.

Total Terminal Required = 806,000 S.F.

1990   DCA   CASE 17

Terminal Square Footage based on Gate Requirements

No. of Narrow-Body Gates x 15,000 S.F./Gate = Terminal Area Requirements

          32 Gates   x 15,000 S.F./Gate = Terminal S.F.

                                        = 480,000 S.F.

No. of Wide-Body Gates x 17,000 S.F./Gate = Terminal S.F.

          13 Gates   x 17,000 S.F./Gate = Terminal S.F.

                                        = 221,000 S.F.

              Total Terminal Required = 701,000 S.F.

BALTIMORE-WASHINGTON INTERNATIONAL AIRPORT
CALCULATIONS

1990   BWI   CASE 2

A. Terminal Square Footage based on Gate Requirements

No. of Narrow-Body Gates x 15,000 S.F./Gate   = Terminal Area Requirements

            29 Gates x 15,000 S.F./Gate   = Terminal S.F.

                                        = 435,000 S.F.

  No. of Wide-Body Gates x 17,000 S.F./Gate   = Terminal S.F.

            15 Gates x 17,000 S.F./Gate   = Terminal S.F.

                                        = 255,000 S.F.

                   Total Terminal Required   = 690,000 S.F.

B. Terminal Square Footage based on T.P.H.P.

Gross Terminal Area = T.P.H.P. x Utilization Factor

                  = 2,508 x 220 S.F./T.P.H.P.

                  =552,000 S.F.

C. Terminal Gates

AIRCRAFT	x	PEAK HOUR FACTOR	=		GATE REQUIREMENT
30 Seats - 5		x 1.12	=	5.60 OR	6
50 Seats - 1		x 1.22	=	1.22 OR	2
95 Seats - 11		x 1.50	=	16.50 OR	17
125 Seats - 2		x 1.72	=	3.44 OR	4
200 Seats - 0		x 2.17	=		0
250 Seats - 6		x 2.50	=	15.00 OR	15

TOTAL GATES REQUIRED = 44

1990   BWI   CASE 6

A.   Terminal Square Footage based on Gate Requirements

No. of Narrow-Body Gates x 15,000 S.F./Gate   = Terminal Area Requirement:
                30 Gates x 15,000 S.F./Gate   = Terminal S.F.
                                               = 450,000 S.F.

  No. of Wide-Body Gates x 17,000 S.F./Gate   = Terminal S.F.
                15 Gates x 17,000 S.F./Gate   = Terminal S.F.
                                               = 255,000 S.F.

                Total Terminal Required   = 705,000 S.F.

B.   Terminal Square Footage based on T.P.H.P.

Gross Terminal Area = T.P.H.P. x Utilization Factor
                    =   2,768 x 220 S.F./T.P.H.P.
                    = 609,000 S.F.

C. Terminal Gates

AIRCRAFT	x	PEAK HOUR FACTOR	=		GATE REQUIREMENT
30 Seats - 4		x 1.12	=	4.48 OR	5
50 Seats - 1		x 1.22	=	1.22 OR	2
95 Seats - 12		x 1.50	=	18.00 OR	18
125 Seats - 1		x 1.72	=	1.72 OR	2
200 Seats - 1		x 2.17	=	2.17 OR	3
250 Seats - 6		x 2.50	=	15.00 OR	15

TOTAL GATES REQUIRED = 45

1990   BWI   - CASE-13

A. Terminal Square Footage based on Gate Requirements

No. of Narrow-Body Gates x 15,000 S.F./Gate   = Terminal Area Requirements

       29 Gates x 15,000 S.F./Gate   = Terminal S.F.

                                       = 435,000 S.F.

No. of Wide-Body Gates x 17,000 S.F./Gate   = Terminal S.F.

       15 Gates x 17,000 S.F./Gate   = Terminal S.F.

                                       = 255,000 S.F.

               Total Terminal Required   = 690,000 S.F.

B. Terminal Square Footage based on T.P.H.P.

Gross Terminal Area = T.P.H.P. x Utilization Factor

                    =   2,598 x 220 S.F./T.P.H.P.

                    = 572,000 S.F.

C. Terminal Gates

AIRCRAFT	x	PEAK HOUR FACTOR	=			GATE REQUIREMENT
30 Seats - 5		x 1.12	=	5.60	OR	6
50 Seats - 1		x 1.22	=	1.22	OR	2
95 Seats - 10		x 1.50	=	15.00	OR	15
125 Seats - 3		x 1.72	=	5.16	OR	6
200 Seats - 0		x 2.17	=			0
250 Seats - 6		x 2.50	=	15.00	OR	15

TOTAL GATES REQUIRED   =   44

1990   BWI   -CASE 17

A. Terminal Square Footage based on Gate Requirements

No. of Narrow-Body Gates x 15,000 S.F./Gate   = Terminal Area Requirements

         30 Gates x 15,000 S.F./Gate   = Terminal S.F.

                                       = 450,000 S.F.

No. of Wide-Body Gates x 17,000 S.F./Gate   = Terminal S.F.

         15 Gates x 17,000 S.F./Gate   = Terminal S.F.

                                       = 255,000

                 Total Terminal Required   = 705,000

B. Terminal Square Footage based on T.P.H.P.

Gross Terminal Area = T.P.H.P. x Utilization Factor

                 =   2,613 x 220 S.F./T.P.H.P.

                 = 575,000 S.F.

C. Terminal Gates

AIRPORT	x	PEAK HOUR FACTOR	=		GATE REQUIREMENT
30 Seats - 4		x 1.12	=	4.48 OR	5
50 Seats - 1		x 1.22	=	1.22 OR	2
95 Seats - 11		x 1.50	=	16.50 OR	17
125 Seats - 3		x 1.72	=	5.16 OR	6
200 Seats - 0		x 2.17	=		0
250 Seats - 6		x 2.50	=	15.00 OR	15

TOTAL GATES REQUIRED   =   45

DULLES INTERNATIONAL AIRPORT
CALCULATIONS

1990   IAD   CASE 2

A. Terminal Square Footages

   Gross Terminal Area = T.P.H.P. x utilization factor
                       = 4,018 x 170 S.F./T.P.H.P.
                       = 683,000 S.F.

   New Construction   = Gross Terminal Area - Existing Area
                       = 683,000 S.F. - 300,000 S.F.
                       = 383,000 S.F.

B. Terminal Costs
   Expansion using the present terminal design
                       = 180,000 S.F. x $111/S.F.
                       = $20.0 Million

   Expansion using low profile terminal design
                       = (New construction - 180,000 S.F.) x $93/S.F.
                       = (383,000 S.F. - 180,000 S.F.) x $93/S.F.
                       = 203,000 S.F. x $93/S.F.
                       = $18.9 Million

   Terminal Cost   = Present design + low profile
                       = $20.0 Million + $18.9 Million
                       = $38.9 Million

C. Gate and Transporter Requirements

No. of Gates:

$$\frac{10 \text{ Gates}}{1.50 \text{ (Peak Hour Factor)}} = 6.7 \text{ or } 6 \text{ Aircraft}$$

$$\frac{6 \text{ 95.Seats}}{6 \text{ Aircraft}}$$

(3 95 seats must use Transporters)

No. of Transporters:

AIRCRAFT		X	TRANSPORTERS PER P.H. DEP.		=	TRANSPORTERS REQUIRED	
			50-80 PAX CAPACITY	85-120 PAX CAPACITY		50-80 PAX Capacity	85-120 PAX CAPACITY
95 Seats	3	x	1	-		3	-
125 Seats	1	x	2	-		2	
250 Seats	12	x	4	3		16	24

Total Each Type Required 21		24
Total Transporters	45	
Spares 1/	9	
Total Transporters Required	54	
Total On Hand	33 2/	
New Transporters Required	21	

Cost = New Transporters X $375,000

    =   21   X $375,000

    = $7,875,000

1/ Assumes one space for every five used.

2/ 21 mobile lounges (50-80 passenger capacity)
   11 Plane mates   (85-120 passenger capacity)
   33 Total transporters.

D. Aircraft Parking Positions

AIRCRAFT		PEAK HOUR FACTOR	=	AIRCRAFT POSITIONS		PARKING REQUIRED
95 Seats (or less)	9	x 1.50	=	13.50	OR	14
125 Seats	1	x 1.72	=	1.72	OR	2
200 Seats	0	x 2.17	=	0	OR	0
250 Seats	12	x 2.50	=	30.00	OR	30
350 Seats	0	x 3.11	=	0	OR	0

Total Parking Positions Required	=	46
Number of Peak Hour Departures at Terminal Gates	=	6
Total Parking Positions To Be Served by Trans-porters	=	40
Existing Parking Positions	=	30
New Positions Required	=	10

Cost = New Positions x 6,000 S.Y. x $40.00/S.F.

    = 10 x 6,000 x $40.00

    = $2.4 Million

1990   IAD   CASE 6

A. Terminal Square Footages

Gross Terminal Area   = T.P.H.P. x utilization factor
                             = 5,952 x 170 S.F./T.P.H.P.
                             = 1,012,000 S.F.

New Construction   = Gross Terminal Area - Existing Area
                             = 1,012,000 S.F. - 300,000 S.F.
                             = 712,000 S.F.

B. Terminal Costs

Expansion using the present terminal design
                             = 180,000 S.F. x $111/S.F.
                             = $20.0 Million

Expansion using low profile terminal design
                             = (New construction - 180,000 S.F.) x
                               $93/S.F.
                             = ($712,000 S.F. - 180,000S.F.) x $93/S.
                             = 532,000 S.F. x $93/S.F.
                             = $49.5 Million

Terminal Cost   = Present Design + Low Profile
                             = $20.0 Million + $49.5 Million
                             = $69.5 Million

C.   Gate and Transporter Requirements

No. of Gates:

$\dfrac{10 \text{ Gates}}{1.50 \text{ (Peak Hour Factor)}}$ = 6.7 or 6 Aircraft

$\begin{array}{l}1\ \ 50\ \ \text{Seats}\\ \underline{5\ \ 95}\ \ \text{Seats}\\ 6\ \text{Aircraft}\end{array}$

(22 95 seats must use transporters)

No. of Transporters:

AIRCRAFT	X	TRANSPORTERS PER P.H. DEP.		=	TRANSPORTERS REQUIRED	
		50-80 PAX CAPACITY	85-120 PAX CAPACITY		50-80 PAX CAPACITY	85-120 PAX CAPACITY
95 Seats	22 x	1	1		21	1
125 Seats	13 x	-	1		-	13
200 Seats	3 x	-	2		-	6
250 Seats	3 x	-	3		-	9
350 Seats	1 x	-	4		-	4
				Total Each Type Required	21	33

Total Transporters   54

Spares 1/   11

Total Transporters Required   65

Total on Hand   33 2/

New Transporters Required   32

Cost = New Transporters X $375,000

$\qquad$ =   32   X $375,000

$\qquad$ = 12,000,000

1/ Assumes one space for every five used.

2/ 21 mobile lounges (50-80 passenger capacity)
   11 Plane-Mates   (85-120 passenger capacity)

   32 Total Transporters

D. Aircraft Parking Positions

AIRCRAFT		PEAK HOUR FACTOR	=	AIRCRAFT POSITIONS		PARKING REQUIRED
95 Seats (or less)	28	x 1.50	=	42.00	OR	42
125 Seats	13	x 1.72	=	22.36	OR	23
200 Seats	3	x 2.17	=	6.51	OR	7
250 Seats	3	x 2.50	=	7.50	OR	8
350 Seats	1	x 3.11	=	3.11	OR	4

Total Parking Positions Required	=	84
Number of Peak Hour Departures at Terminal Gates	=	6
Total Parking Positions To Be Served by Transporters	=	78
Existing Parking Positions	=	30
New Positions Required	=	48

Cost = New Positions x 6,000 S.Y. x $40.00/S.F.

= 43 x 6,000 x $40.00

= $11.5 Million

A. <u>Terminal Square Footages</u>

Gross Terminal Area = T.P.H.P. x utilization factor
                    = 4,000 x 170 S.F./T.P.H.P.
                    = 680,000 x S.F.

New Construction   = Gross Terminal Area - Existing Area
                    = 680,000 S.F. - 300,000 S.F.
                    = 380,000 S.F.

B. <u>Terminal Costs</u>

Expansion using the present terminal design
                    = 180,000 S.F. x $111/S.F.
                    = $20.0 Million

Expansion using low profile terminal design
                    = (New construction - 180,000 S.F.) x $93/S.F.
                    = (380,000 S.F. - 180,000 S.F.) x $93/S.F.
                    = 200,000 S.F. x $93/S.F.
                    = $18.6 Million

Terminal Cost   = Present design + low profile
                    = $20.0 Million + $18.6 Million
                    = $38.6 Million

C. Gate and Transporter Requirements

No. of Gates:

$$\frac{10 \text{ Gates}}{1.50 \text{ (Peak Hour Factor)}} = 6.7 \text{ or } 6 \text{ Aircraft}$$

$$\frac{\begin{array}{l}3 \quad 30 \text{ Seats}\\ 3 \quad 95 \text{ Seats}\end{array}}{6 \text{ Aircraft}}$$

(5   95 seats must use transporters)

No. of Transporters:

AIRCRAFT	X	TRANSPORTERS PER P.H. DEP.		=	TRANSPORTERS REQUIR	
		50-80 PAX CAPACITY	85-120 PAX CAPACITY		50-80 PAX CAPACITY	85-120 PAX CAPACITY
95 Seats	5 x	1	-		5	-
125 Seats	2 x	2	-		4	-
200 Seats	1 x	3	-		3	-
250 Seats	11 x	4	3		8	27

Total Each Type Required	20	27
Total Transporters	47	
Spares 1/	9	
Total Transporters Required	56	
Total on Hand	33 2/	
New Transporters Required	23	

Cost = New Transporters X $375,000

   =   23   X $375,000

   = $8,625,000

1/ Assumes one space for every five used.

2/ 21 mobile lounges (50-80 passenger capacity)
   11 Plane-Mates   (85-120 passenger capacity)
   33 Total Transporters

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D. Aircraft Parking Positions

AIRCRAFT	PEAK HOUR FACTOR	=	AIRCRAFT POSITIONS		PARKING REQUIRED
95 Seats (or less)	11 x 1.50	=	16.50	OR	17
125 Seats	2 x 1.72	=	3.44	OR	4
200 Seats	1 x 2.17	=	2.17	OR	3
250 Seats	11 x 2.50	=	27.50	OR	28
350 Seats	0 x 3.11	=	0	OR	0

Total Parking Positions Required = 52

Number of Peak Hour Departures at Terminal Gates = 6

Total Parking Positions To Be Served by Trans-porters = 46

Existing Parking Positions = 30

New Positions Required = 16

Cost = New Positions x 6,000 S.Y. x $40.00/S.F.

= 16 x 6,000 x $40.00

= $3.8 Million

1990   IAD   CASE 17

A. Terminal Square Footages

Gross Terminal Area = T.P.H.P. x utilization factor
              = 3,923 x 170 S.F./T.P.H.P.
              = 667,000 S.F.

New Construction   = Gross Terminal Area - Existing Area
              = 667,000 S.F. - 300,000 S.F.
              = 367,000 S.F.

B. Terminal Costs

Expansion using the present terminal design
              = 180,000 S.F. x $111/S.F.
              = $20.0 Million

Expansion using low profile terminal design
              = (New construction - 180,000 S.F.) x $93/S.F.
              = (367,000 S.F. - 180,000 S.F.) x $93/S.F.
              = 187,000 S.F. x $93/S.F.
              = $17.4 Million

Terminal Cost   = Present design + low profile
              = $20.0 Million + $17.4 Million
              = $37.4 Million

C. Gate and Transporter Requirements

No. of Gates:

$$\frac{10 \text{ Gates}}{1.50 \text{ (Peak Hour Factor)}} = 6.7 \text{ or } 6 \text{ Aircraft}$$

3   30 Seats
3   95 Seats
6 Aircraft

(5   95 seats must use transporters)

No. of Transporters:

AIRCRAFT	X	TRANSPORTERS PER P.H. DEP.		=	TRANSPORTERS REQUIRE	
		50-80 PAX CAPACITY	85-120 PAX CAPACITY		50-80 PAX CAPACITY	85-120 PA CAPACITY
95 Seats	5 x	1	-		5	-
125 Seats	2 x	2	-		4	-
200 Seats	1 x	3	-		3	-
250 Seats	11 x	4	3		8	27

Total Each Type Required	20	27
Total Transporters	47	
Spares 1/	9	
Total Transporters Required	56	
Total on Hand	33 2/	
New Transporters Required	23	

Cost = New Transporters X $375,000

= 23   X $375,000

= $8,625,000

1/ Assumes one space for every five used.

2/ 21 mobile lounges (50-80 passenger capacity)
   11 Plane-Mates   (85-120 passenger capacity)
   33 Total Transporters

D. Aircraft Parking Positions

AIRCRAFT		PEAK HOUR FACTOR	=	AIRCRAFT POSITIONS		PARKING REQUIRED
95 Seats (or less)	11	x 1.50	=	16.50	OR	17
125 Seats	2	x 1.72	=	3.44	OR	4
200 Seats	1	x 2.17	=	2.17	OR	3
250 Seats	11	x 2.50	=	27.50	OR	28
350 Seats	0	x 3.11	=	0	OR	0

Total Parking Positions Required = 52

Number of Peak Hour Departures at Terminal Gates = 6

Total Parking Positions To Be Served by Transporters = 46

Existing Parking Positions = 30

New Positions Required = 16

Cost = New Positions x 6,000 S.Y. x $40.00/S.F.

= 16 x 6,000 x $40.00

= $ 3.8 Million

IAD   AUTO PARKING REQUIREMENTS

- Present capacity   = 3,400
- Demand Factor   = 2.2 Per 1,000 Originating Passengers
- Cost at $1,000 per space

Case	Originating Pax. (000)	Auto Parking Demand	Additional Spaces Required	Cost ($ Millions)
2	4,639	10,200	6,800	6.8
6	7,303	16,100	12,700	12.7
13	3,864	8,500	5,100	5.1
17	4,949	10,900	7,500	7.5